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A MINITAB MACRO FOR THE KAPLAN-MEIER PRODUCT LIMIT
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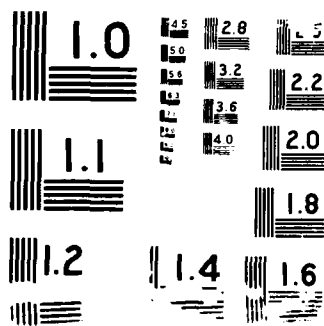
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ABSTRACT

A Minitab macro to compute the K-M ple and the Tarone-Ware class of tests is given. The macro, tar.war, prints the K-M ple for both groups, gives simultaneous plots of the survival curves and calculates the one and two-sided P level of the selected Tarone-Ware test.

AMS (MOS) Subject Classification: 62-04

Key Words: Kaplan-Meier; Macro; Minitab; Product-limit estimator;
Tarone-Ware tests

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A MINITAB MACRO FOR THE KAPLAN-MEIER PRODUCT LIMIT
ESTIMATOR AND THE TARONE-WARE CLASS OF TESTS

Andrew P. Soms*

1. Introduction

Minitab is a user-friendly statistical computer package widely used in industry and academia. For more details, see Ryan, Joiner and Ryan (1985) or Cobb and Gifford (1986). The Kaplan-Meier plot and the Tarone-Ware class of tests are often used in biostatistics and reliability theory to compare two survival distributions. For definitions, assumptions and examples, see Brown, and Hollander (1977) or Miller (1981).

As described in Miller (1981, pp. 94-104), the Tarone-Ware class of tests is generated by allowing the power of the sample size to run from zero (inclusive) up to and including one. The value 0 corresponds to the Mantel-Haenszel test, .5 to the Tarone-Ware and 1 to the Tarone-Ware version of Gehan's test. This power parameter is specified by the user in the MINITAB constant k4. Miller asserts that the Tarone-Ware class of tests allows the censoring distributions to be different, while Gehan's test does not. However, he also cites evidence (Miller, 1981, pp. 89-94) that Gehan's test appears to be insensitive to differences in censoring distributions, so it is not clear which test should be used. A MINITAB macro to calculate Gehan's test has been given by Soms (1988).

The main idea of the program is to first break ties between censored and completed observations by adding to the censored observations one-half of the

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smallest non-zero difference for the ordered combined observations. This does not change the K-M ple or Tarone-Ware tests. Then, using an extension of "Macro for obtaining distinct values and replicate counts from a column of replicated data" by Gunter, Minitab Users' Group Newsletter, 5 (1984), 1, an ordered table of distinct values, together with total replications, type of observation (censored or completed), number in group one and number in group two, is constructed. From this, the K-M ple and the Tarone-Ware test are then readily computed.

An example from Miller (1981, pp. 203-207) has been worked in the Appendix and agrees with Miller's solution.

The macro listed in the Appendix can be modified by the user, if desired, by his computer's editor. The data can be conveniently read in from a file by the Minitab 'read' command, as was done for the example in the Appendix. The macro can easily be used by scientists not familiar with statistics and/or more complex statistical computer packages to quickly assess the significance of their data. For University of Wisconsin-Madison users, it may be possible to transfer the macro directly from the Center for the Mathematical Sciences VAX 780 to the user's computer and interested persons should contact the author.

The author would appreciate any comments and suggestions from researchers using the macro.

References

- Brown, B. W., Jr. and M. Hollander, "Statistics a biomedical introduction", New York, John Wiley, 1977.
- Cobb, G. and J. Gifford, Review of "Minitab handbook (Second edition)", Journal of the American Statistical Association 81 (1986), 1127-1129.

Gunter, B., "Macro for obtaining distinct values and replicate counts from a column of replicated data", Minitab Users' Group Newsletter 5 (1984), 1.

Miller, R. G., Jr., "Survival analysis", New York, John Wiley, 1981.

Ryan, B. F., B. L. Joiner and T. A. Ryan, Jr., "Minitab handbook (Second edition)", Boston, Duxbury Press, 1985.

Soms, A. P., "A Minitab macro for the Kaplan-Meier product limit estimator and Gehan's test", TSR #88-15, Center for the Mathematical Sciences, University of Wisconsin-Madison, 1988.

Appendix

We include here the listing of the macro and a worked example from Miller (1981).

```

needho
macro TarWare for calculating the Kaplan-Meier plot and Tarone-Ware
class of tests
submitted by Andrew P. Soos, CMS, U of Wisconsin-Madison, 608-263-2661, and
U of Wisconsin-Milwaukee, 414-229-4307, January 25, 1988
input: data for sample 1 in c13, indicators (0 for censored
and 1 for completed) in c14, same for sample 2 in c16-c17,
k4 is exponent of weights, assumed powers of ni with
0. .5, 1 giving the Mantel-Haenszel, Tarone-Ware
and Gehan tests, respectively.
scratch: c1-c12, c19, k1-k3
output: c7-c10 K-M plot, simultaneous survival plots, c7(1)
standardized Tarone-Ware test for group 1, c8(1)
1-tailed P-value that group two is better than group 1.
assuming normal approximation.
comments: All possible ties are allowed. The sorting algorithm is
an extension of the sorting algorithm by Bert Gunter,
Minitab Users' Group Newsletter, October 1984. The same
comments made there apply here - a program based on
column operations is substantially faster than one on
row operations.
Each group must contain at least 2 completed and
1 censored observation.
For further references see Statistics A Biomedical
Introduction, Brown and Hollander, or Survival
Analysis, Miller.
program comments:
1/2 * smallest non-zero difference between ordered values added
to censored observations to eliminate ties between completed
and censored observations. This does not change K-M plot or
Tarone-Ware tests. The ordered distinct values are put in c2,
total replications in c3, indicator variables in c4, # in
sample 1 in c5, # in sample 2 in c6.
let k1=count(c13)
set c15 # 1 for sample one
k1(1)
end
let k1=count(c16)
set c18 # 0 for sample two
k1(0)
end
copy c13-c15 c1-c3;
use c14=0.
copy c13-c15 c4-c6;
use c14=1.
copy c16-c18 c7-c9;
use c17=0.
copy c16-c18 c10-c12;
use c17=1.
stack c13 c16 c19
sort c19 c19
diff c19 c19
copy c19 c19;
omit c19='.',0.
let k1=min(c19)/2 # 1/2 * smallest non-zero difference
let c1=c1+k1
let c7=c7+k1
stack (c1-c3) (c4-c6) (c7-c9) (c10-c12), (c1,c4,c5)
eras c2 c3 c8-c12
stack (c1,c4,c5) (c1,c4,c5), (c1,c4,c5)

```



```

copy c1 c2
sort c2,c4,c5 c2,c4,c5
stack (0,1,1) (c2,c4,c5) (c2,c4,c5)
diff c2 c2
copy c2 c2:
omit c2=.
code (0)1 c2 c3
let c3=c3-c2
pars c3 c3
pars c4 c4
pars c5 c5
let k1=c3(count(c3))
let k2=c4(count(c4))
let k3=c5(count(c5))
let c3=sign(c2)*c3
stack c2 0 c2
let c4=sign(c2)*c4
let c5=sign(c2)*c5
copy c3 c3:
omit c3=0.
copy c4 c4:
omit c4=0.
copy c5 c5:
omit c5=0.
stack 0 c3 k1 c3
stack c4 k2 c4
stack c5 k3 c5
diff c3 c3
copy c3 c3:
omit c3=.
let c3=(c3+1)/2 # number of replications
diff c4 c4
copy c4 c4:
omit c4=.
code (1:k2)1 c4 c4 # 1 if completed, 0 otherwise
diff c5 c5
copy c5 c5:
omit c5=.
let c5=c5/2 # number in sample 1
let c6=c3-c5 # number in sample 2
copy c2 c2:
omit c2=0.
pars c2 c2 # distinct values
# calculation of K-M ple for both samples
let k1=sum(c5)
copy c2,c4,c5 c7,c8,c9:
omit c5=0.
stack 0 c9 c10
pars c10 c10
let k2=count(c10)
copy c10 c10:
omit k2:
let c10=k1-c10 # risk set for sample 1
copy c7,c9,c10 c7,c9,c10:
use c8=1.
let c8=(c10-c9)/c10
parp c8 c8 # K-M ple for sample 1
name c7 'com ob 1',c8 'K-M 1',c9 'reps'
print c7,c9,c8
let k1=sum(c6)

```

```

copy c2,c4,c6 c9,c10,c11;
omit c6=0;
stack 0 c11 c12
para c12 c12
let k2=count(c12)
copy c12 c12;
omit k2;
let c12=k1-c12 # risk set for sample 2
copy c9,c11,c12 c9,c11,c12;
use c10=1;
let c10=(c12-c11)/c12
para c10 c10 # K-M ple for sample 2
name c9 'com ob 2', c10 'K-M 2', c11 'reps'
print c9,c11,c10
echo
#
#
#
noecho
mplot c8 c7, c10 c8
echo
#
#
#
noecho
# calculation of Tarone-Ware test for sample 1 and approximate
# P values
let k1=sum(c5)
let k2=sum(c6)
para c5 c7
para c6 c8
let c7=k1-c7
let c8=k2-c8
copy c4-c8 c4-c8;
omit c4=0;
rsum c5-c8 c9
let c10=c9**k4 # these are the Tarone-Ware weights
let c11=c10*(c5-(c5+c7)*(c5+c6)/c9) # numerator summands of T-W
let c12=c9**2*(c9-1)
copy c5-c8 c10 c12 c5-c8 c10 c12;
omit c12=0;
let c12=c10**2*(c5+c6)*(c7+c8)*(c5+c7)*(c6+c8)/c12
erase c7-c9
let c7(1)=sum(c11)/sqrt(sum(c12)) # standardized T-W
let k2=c7(1)
let k1=abs(c7(1))
cdf k1 k1;
norm 0 1;
cdf k2 k2;
norm 0 1;
let c8(1)=1-k2 # 1-tail P value that group 2 is better than 1
let c9(1)=2*(1-k1) # 2-tail P value. This will be twice 1-tail
# P value only if 1-tail P value is .5.
name c7 'at T-W', c8 '1-tail P', c9 '2-tail P'
print c7-c9
echo
end

```

MTB > / example from Miller, pp. 203-207

MTB > let k4=0

MTB > read 'emb.1' c13 c14

11 ROWS READ

ROW C13 C14

1	9	1
2	13	1
3	13	0
4	18	1

MTB > print c13-c14

ROW C13 C14

1	9	1
2	13	1
3	13	0
4	18	1
5	23	1
6	28	0
7	31	1
8	34	1
9	45	0
10	48	1
11	161	0

MTB > read 'emb.2' c16 c17

12 ROWS READ

ROW C16 C17

1	5	1
2	5	1
3	8	1
4	8	1

MTB > print c16-c17

ROW C16 C17

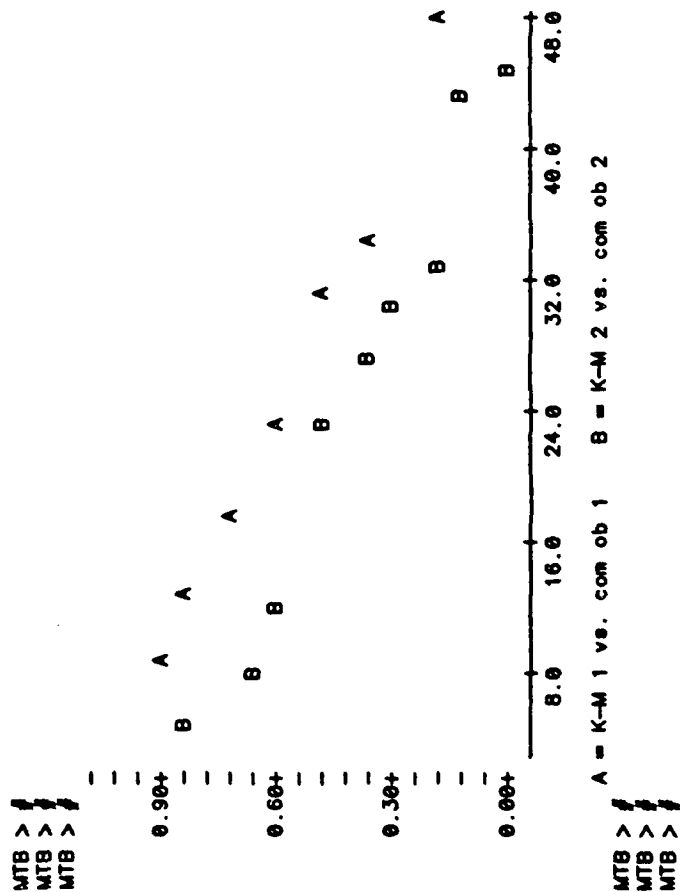
1	5	1
2	5	1
3	8	1
4	8	1
5	12	1
6	16	0
7	23	1
8	27	1
9	30	1
10	33	1
11	43	1
12	45	1

```

MTB > exec 'ter.war'
ROW com ob 1 reps K-M 1
1 9 1 0.909091
2 13 1 0.818182
3 18 1 0.715909
4 23 1 0.613636
5 31 1 0.490909
6 34 1 0.368182
7 48 1 0.184091

ROW com ob 2 reps K-M 2
1 5 2 0.833333
2 8 2 0.666667
3 12 1 0.583333
4 23 1 0.486111
5 27 1 0.388889
6 30 1 0.291667
7 33 1 0.194444
8 43 1 0.097222
9 45 1 0.000000

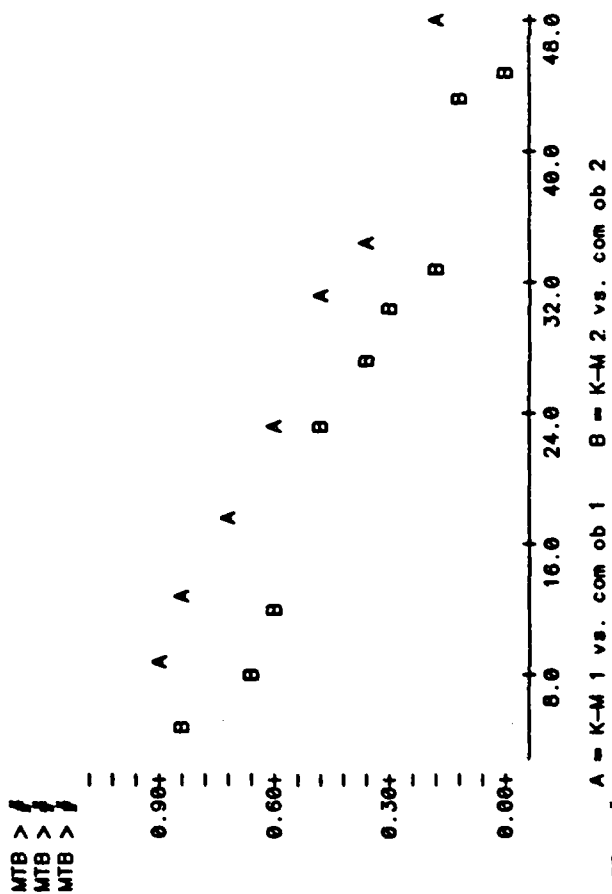
```



ROW at T-W 1-tail P 2-tail P
1 -1.84293 0.06733 0.0653392

MTB > end
MTB > let k4=1
MTB > exec 'tar.war'
ROW com ob 1 reps K-M 1
1 9 1 0.909091
2 13 1 0.818182
3 18 1 0.715909
4 23 1 0.613636
5 31 1 0.490909
6 34 1 0.368182
7 48 1 0.184091

ROW com ob 2 reps K-M 2
1 5 2 0.833333
2 8 2 0.666667
3 12 1 0.583333
4 23 1 0.486111
5 27 1 0.388889
6 30 1 0.291667
7 33 1 0.194444
8 43 1 0.097222
9 45 1 0.000000



ROW	at T-W	1-tail P	2-tail P
1	-1.65025	0.950554	0.0988926

MTB > end
MTB > outfile

END

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